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WAREHOUSE PERFORMANCE IMPROVEMENT AT LINFOX LOGISTICS INDONESIA

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Abstract–*The objective of this research is to provide alternative solutions for Linfox Logistics Indonesia (LLI) in facing warehouse performance issues. The main warehouse performance indicators called Customer Case Filling on Time (CCFOT) and Case Picking Productivity failed to achieve the target. Several analyses were carried out regarding current dispatch process, value stream mapping, and root causes identification. The results find that much waste occurred in dispatch process. Proposed improvements include reengineering business process and implementing ABC cycle counting. Using Monte Carlo simulation, each solution is examined to find expected lead time and customer case filling on time. Expected cases picking productivity is estimated by eliminating the waste. It is shown that reengineering dispatch process and implementing ABC cycle counting could eliminate all wastes, shorten delivery lead time, and make both KPIs surpass the target.*

Keywords: warehouse, dispatch process, Monte Carlo simulation, ABC cycle counting, Linfox Logistics Indonesia

1. Introduction

Linfox Logistics Indonesia (LLI) was founded in 2001 in Jakarta, Indonesia. LLI only served logistic sector over Fast Moving Consumer Goods (FMCG) company which is Unilever Indonesia (ULI). Logistics services offered by LLI are warehousing, distribution, and value added for customer. During 12 years operating in Indonesia, LLI has been rapidly growing with its success in designing and implementing technology, developing continuous logistics solution, and trying to understand customers' needs. As a 3PL company, LLI has striven to deliver their best services in order to maintain client's service level. This requires skillful supply chain management in dealing with complex coordination that LLI can qualify with warehouse management and transportation as their core competences. In addition, the need for effective and efficient business process is also crucial for LLI to satisfy their client.

In this paper, warehouse KPIs are used as assessment in identifying business issues symptoms that takes place in LLI's Warehouse CDC01. Two warehouse KPIs that being LLI's concern are *customer case filling on time* (CCFOT) and *case picking productivity* which targeted to reach 92% and 200 cs/man hour, respectively. During 2011, both KPIs performed unsatisfying with actual achievements were 89.27% for CCFOT and 163 cs/man hour for *case picking productivity*. This research is aimed to construct possible solutions that can make *CCFOT* and *case picking productivity* achieve or even surpass the target by reengineering business process and implementing better cycle counting method. Several analyses toward current dispatch process are conducted first to give insights of how LLI run their dispatch process. The analyses also include information and material flow to identify the gap or waste in the process. Possible solutions are then run for Monte Carlo simulation to predict the likely outcome in the real system. At the end, this research is expected to give insights and help management in making decisions to overcome their problems with possible-to-implement solutions.

2. Business Issue Exploration

A. Conceptual Framework

This research is constructed by utilizing 4D method to plan and structure information needed comprises Definition stage, Diagnosis stage, Designing stage, and Delivery stage as shown in Figure 1.

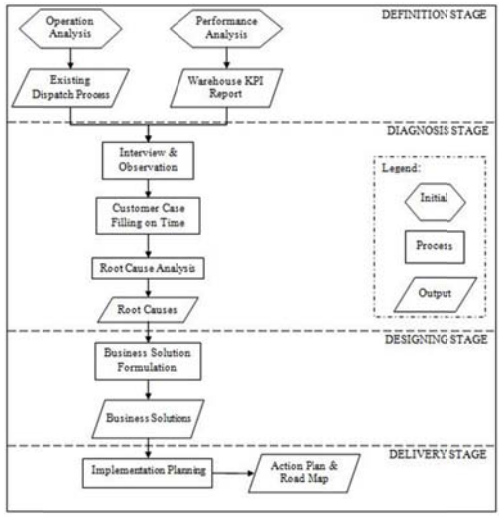

Figure 1. Conceptual Framework

Definition stage is a preparation stage where all information related to LLI are collected. In this stage, the limitation of this research is defined as well as research's objective. Business analysis for symptoms and root causes identification are given in diagnosis stage through interviews, observations, and framework construction. In designing stage, solution map to overcome emerging root causes is created as well as Monte Carlo simulation toward business solutions to give a prediction of what the likely outcomes in the real system. In the last stage, a set of implementation plan is created in delivery stage to give guidance to management of what to start first in implementing business solutions.

B. Method of Data Collection and Analysis

The data collected can be divided into primary data and secondary data. Primary data are sourced directly through interviews and observations. Several informants are selected specifically for research scope, comprise Transport Manager, Assistant Manager of Transport, Assistant Manager of Operations, and Inventory Controller. Transport Manager was interviewed to define Warehouse CDC01 KPIs that being management's concern. Interview with Assistant Manager of Transport was conducted to gain understanding about dispatch process, transportation, and partnership with transporters. Assistant Manager of Operations was interviewed to gain information about warehousing and inventory management. Inventory Controller was interviewed to gain information related to the replenishment. Observations were conducted in Warehouse CDC01 area specifically dispatch area.

Secondary data were collected through literature study and LLI's document. Secondary data are needed to support and complement the discovery of this research. Literature study were obtained from textbooks such as Operation Management, Supply Chain Logistics Management, Designing and Managing the Supply Chain, journals related to supply chain and logistics, and also information from internet that are relevant to this research. LLI's documents were also reviewed such as KPIs report during 2011, inbound and outbound data, and inventory accuracy data.

C. Analysis of Business Situation

During 2011, both KPIs showed unsatisfying result. The target for CCFOT was set to 92% whilst the actual average achievement was only 89.27%. In case picking productivity, the target was set to 200 cs/man hour whilst the actual average achievement was only 163 cs/man hour. From these findings, a more deeply analysis was conducted in the next part. Both KPIs achievement during 2011 are reviewed in Figure 2 and Figure 3. As CCFOT and *cases picking productivity* were defined as major problems that need to be solved, the root causes that lead to these problems must be identified to prevent these issues emerge in the future. First analysis in root cause analysis is conducted by using Pareto analysis to identify the key causes that contributes significantly to major problem, which in this case is *CCFOT did not achieve target 92%*.

Figure 2. Customer Case Filling on Time Graphic

Figure 3. Case Picking Productivity Graphic

Pareto Analysis

According to Russell & Taylor (2006), Pareto analysis is a method for identifying the cause of poor quality, which usually shows the most quality problems result from only a few causes. The Pareto principle rule is 80/20 which means 80% of problem was caused by 20% of particular cause. To construct Pareto analysis, an interview was conducted with Nawa Aji Respati to define the cause categories and the magnitude of each cause to delayed shipment. Table 1 summaries the cause categories with their magnitude and Figure 4 visualizes the pareto diagram.

Table 1. The Impact of Causes on Delayed Shipment

No.	Problems	Causes	Percentage
1.	Insufficient transporter's checkers capacity	Too few transporter's checkers	4%
2.	Transporters send inappropriate trucks	Trucks ordering is done without re-	2%

		confirmation	
3.	Picker finds many goods not in right quantity at pickface area	Replenishment at pickface area is based on zero stock	80%
		Replenishment is done without cross-checking	4%
		Cycle counting is based on high-value and fast-moving items	10%

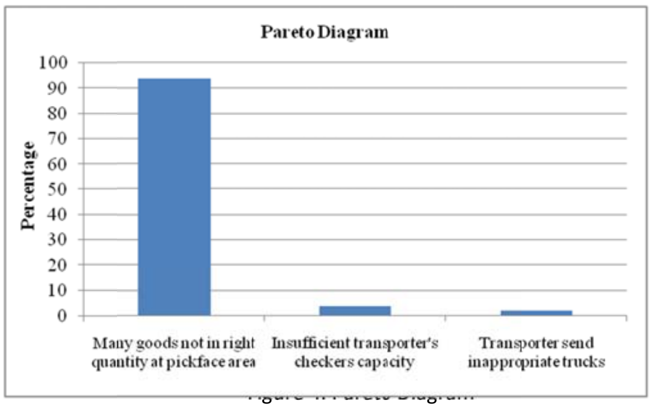

Figure 4. Pareto Diagram

From Pareto diagram in Figure 4, the causes that have greater impact to the delayed shipment are consolidation of replenishment at pickface area is based on zero stock, replenishment is done without cross-checking, and cycle counting is based on high-value and fast-moving items. These three causes are together responsible for the finding of picker finds many goods not in right quantity at pickface area that further significantly caused CCFOT did not achieve target 92%. This means that LLI get the biggest advantage by tackling those three causes. Once this done, it may be worth looking at tackling the rest causes, which are too few transporter’s checkers and trucks ordering is done without re-confirmation.

Pareto analysis gives a helpful overview in comparing the magnitude of each cause to the major problem. However, this cannot identify where the causes occur in the work flow and what possible improvements that can be applied to overcome the causes. In order to give a comprehensive work flow which also defines where the bottleneck is, a tool is needed to elaborate each works flow into detailed cycle time. For this purpose, value stream mapping is constructed and explained in the next section.

Value Stream Mapping: Current State Map

Value stream mapping is a tool for mapping the material and information flows required to coordinate the activities performed by manufacturers, suppliers, and distributors to deliver products to customers (Irani and Zhou, 2011). In this research, the entities that involve in value stream mapping are ULI, LLI, and transporters. Value stream mapping is not only mapping the flow of material and information but also providing the results for how each operation, queue, and resource performed over the duration of the run (Nielsen, 2008, p.1).

The current state map for Warehouse CDC01 dispatch process is shown in Appendix 1. The flow starts from information flow when customers make daily orders to ULI in form of purchase order (PO). The PO is then processed by ULI as sales order (SO) and sends it to LLI's planner. The SO contains information such as the name of stores, destination, SKUs quantity, requested date of delivery, etc. Based on this information, planner is responsible for making shipment schedule in form of expedition report and contacting transporters for additional trucks requirement. Transporters then send the trucks to Warehouse CDC01 and the next process involved mainly materials flow starts from register – approval – picking – checking – loading – shipping.

Since the information flow occurs online and it is assumed that there is no system failure that terminates all established communication, so the next processes become critical processes that are analyzed deeply including the duration, value-added time and non-value added time. Through interviews and observations, there are three identified areas where the waste takes place which are approval, picking, and checking process.

Approval process is a process where planner team approve required document such as booking code and registration sheet from transporter if they match as requested. In this process, the non-value-added identified is transporter sends inappropriate additional trucks which accounts for 240 minutes delayed estimation. The value-added itself only takes 10 minutes. This delay arises due to waiting time needed to re-send the appropriate trucks. The actual swing (non-commitment) is 5-10% per day while the target is 0% per day. This swing can be caused by one transporter or several transporters. This non-value-added time can be eliminated by reengineering the process which is creating re-confirmation process as early notification system. It is symbolized in *Kaizen* burst.

Picking process also indicates the non-value-added. Picking process is a process of picking goods by picker from particular aisle location at pickface area for order fulfillment. This process is disturbed by the finding of many goods not in right quantity at pickface area. The time that needed by picker to finish picking with this non-value-added is 73 minutes while it can take only 30 minutes by eliminating the non-value-added. The extra time regarding non-value-added arises from waiting time needed to replenish the shortage at pickface area. In addition to time, picker's productivity is also influenced. Picker's productivity is targeted to reach 200 cs/man hour while the actual is only 163 cs/man hour on average. This non-value-added can be eliminated by reengineering the process which are creating just-in-time replenishment, replenishment cross-checking, and implementing ABC cycle counting.

The last non-value-added is found in checking process. This is the process where LLI's checker and transporter's checker check the goods regarding quantity, SKU, and condition. Checking process is run with 13 LLI's checkers and 7 transporter's checker. It takes about 56 minutes to finish checking, while the value-added only takes 30 minutes. This extra 26 minutes of non-value-added arises from waiting time of LLI's checkers toward transporter's checkers to finish checking. To eliminate non-value-added time, the process can be engineered by implementing "one-check loading" strategy with punishment system.

To strengthen the finding of root causes in Pareto analysis, more complex tool that is able to identify root causes along with their correlation is required. In this research, current reality tree (CRT) is used and explained in the next section.

Current Reality Tree

Figure 5 illustrates a CRT diagram for Warehouse CDC01 dispatch process. It represents the various undesirable effects (UDEs) associated with warehouse KPIs, as well as a series of causal relationships. At the top of the diagram is the most important UDE, the UDE that is fundamental in the entire process, which is *customer case filling on time (CCFOT) does not achieve target 92%*. It is suggested to explore other UDEs and their root causes, the relationship between them, and the core constraint (one or several root causes) that leads to the fundamental UDE (AGI, 2009, pp. 1-10).

CRT diagram is constructed by working from this fudamental UDE at the top through proximate causes, and finally root causes. The relationship between each UDE is also explored in order to identify root causes that lead to the rest and ultimately result in *customer case filling on time does not achieve target 92%*. This could be the result of causes in three categories: (1) process (replenishment), (2) method (cycle counting), (3) resources (people), and (4) partnership (transporters).

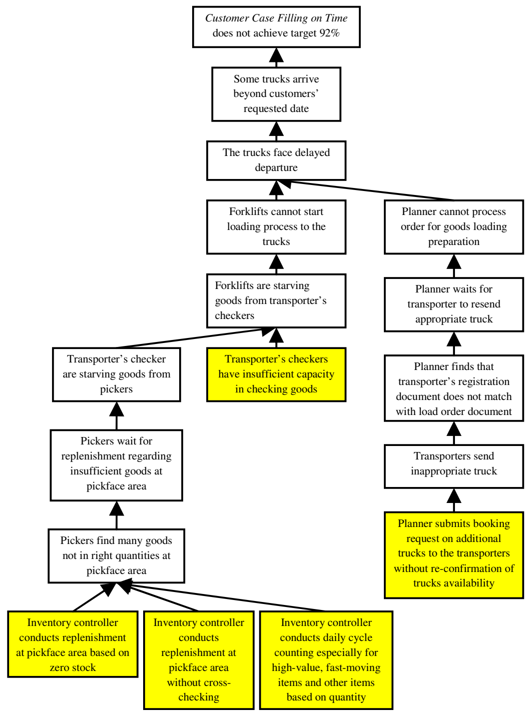

Figure 5. Current Reality Tree for Warehouse CDC01 Dispatch Process

Process issues that cause the raising of the UDEs are specifically replenishment processes. Two kinds of replenishment issues identified are replenishment is done based on zero stock and replenishment is done without cross-checking. The replenishment here is related to the execution of replenishment that is done by reachtruck replenishment to pickface area. Regarding replenishment based on zero stock, the main issue lies on the absence of goods at pickface area when needed by picker. Since the replenishment is based on zero stock, the absence of goods at pickface area occurred frequently. Picker is responsible for picking goods from pickface area to loading area. This absence of goods wastes pickers' movement so that lower their productivity. The second replenishment issue comes up regarding replenishment that is done without cross-checking. Inspection conducted by inventory team found that forklifts operator (reachtruck replenishment) misplaces goods at pickface area. Both replenishment issues responsible for the finding of UDE of *pickers find many goods not in right quantities at pickface area*.

Regarding method, cycle counting also contributes to the rising of UDE of *pickers find many goods not in right quantities at pickface area*. Cycle counting is conducted daily by inventory team with 5-6 SKUs must be counted especially for high-value, fast-moving items. Other items are cycle counted based on their quantity. This current method of cycle counting contributes to the low level of inventory accuracy.

The resources factor specifically insufficient capacity of transporter's checkers mainly contributes to the rising of UDE of *forklifts are starving goods from transporter's checkers*. Transporter's checkers perform goods checking in loading area and signing loading sheet document in order to handover to LLI's checker so that forklifts can start loading process. The main problem lies on how fast they can check the goods. Compare to LLI's checkers, transporter's checkers are lesser in number. Checking process is done with 13 LLI's checkers and 7 transporter's checkers while the trucks already arrive at loading gate waiting for transporter's checkers finish checking.

In partnership, LLI collaborates with about 13 transporters in distributing goods from manufacturer to warehouse and from warehouse to the customers. Transporters must fulfill their obligations in sending the trucks in accordance with quantity, specification, and time requested. In fact, transporters still do not fully commit with their services mainly due to miscommunication between LLI and transporters. This miscommunication lies on planner submits booking request on additional trucks to the transporters without re-confirmation of truck availability that causes the rising of UDE of *transporters send inappropriate trucks*.

Summarizing these findings based on Figure 5, five root causes are identified as follow:
1. Inventory controller conducts replenishment at pickface area based on zero stock
2. Inventory controller conducts replenishment at pickface area without cross-checking
3. Inventory controller conducts daily cycle counting especially for high-value, fast-moving items and other items based on quantity
4. Transporter's checkers have insufficient capacity in checking goods
5. Planner submits booking request on additional trucks to the transporters without re-confirmation of trucks availability

All of these root causes are identified as the core constraints that prevent warehouse CDC01 from achieving its goal, which is customer case filling on time target 92%. Some of these root causes also contribute to the management failure in achieving cases picking productivity KPI target 200 cs/man hour, which are the first three root causes above.

3. Business Solution

A. Alternative of Business Solution

In this research, the possible solutions are constructed by using Future Reality Tree as shown in Figure 6.

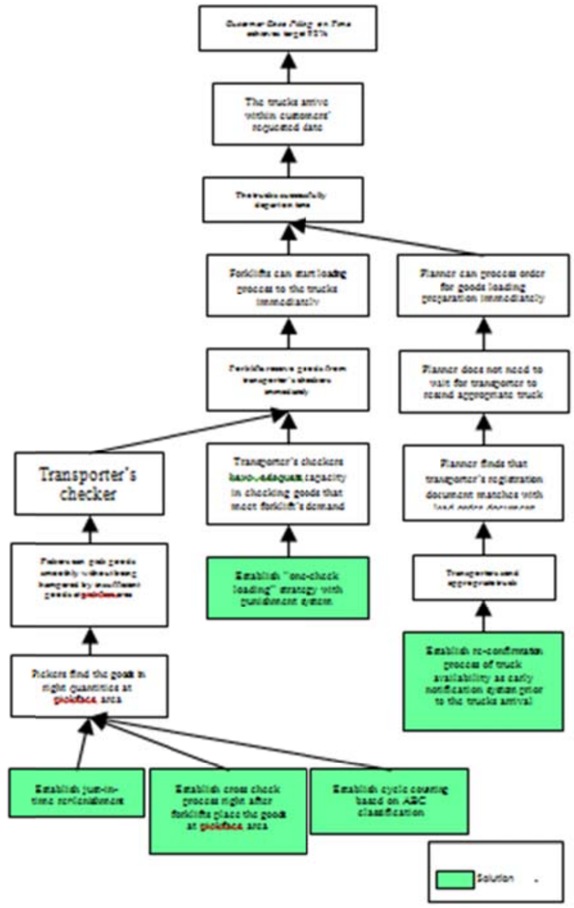

Figure 6. Future Reality Tree for Warehouse CDC01 Dispatch Process

The UDE (Undesirable effect) in Current Reality Tree, which is *customer cases filling on time does not achieve target 92%* will be the DE (Desired Effect) for Future Reality Tree, which is *customer cases filling on time achieves target 92%*. Table 2 below lists several possible solutions that can address warehouse CDC01 problems.

Table 2 List of Possible Solutions with Their Related Root Causes

Possible Solutions	**Root Causes**
Establish just-in-time replenishment	Inventory controller conducts replenishment at pickface area based on zero stock
Establish cross check process right after forklifts place the goods at pickface area	Some forklifts misplace goods at pickface area

Establish cycle counting based on ABC classification	Inventory controller regularly conducts cycle counting especially for high-value, fast-moving items and other items based on quantity
Establish "one-check loading" strategy with punishment system	Transporter's checkers have insufficient capacity in checking goods
Establish re-confirmation process of truck availability as early notification system prior to the trucks arrival	Planner submit booking request on additional trucks to the transporters without re-confirmation of truck availability

B. Analysis of Business Solution

Business solutions that have been constructed are now run for Monte Carlo simulation to predict the likely outcome of real system. Monte Carlo simulation is a statistical method that utilizes sequences of random number to perform the simulation (CSEP, 1995). The first thing that needs to be defined prior to constructing Monte Carlo simulation is random variable. This is the variable that related to uncertainty. In this research, there are two kinds of random variable, estimated lead time and CCFOT of each business solutions. The lead time is calculated by eliminating non-value added time as results from implementing each business solution whilst the expected CCFOT is calculated by eliminating number of delayed cases as results from implementing each business solution Table 3 summarizes estimated lead time reduction and delay reduction.

Table 3. Estimated Lead Time Reductions and Delay Reduction

No.	Business Solution	Estimated LT Reduction (min)	Estimated Delay Reduction
1	Just-in-time replenishment	14	80%
2	Replenishment cross-checking	14	4%
3	ABC cycle counting	14	10%
4	One-check loading strategy	26	4%
5	Re-confirmation process	230	2%
Total		**271**	**100%**

To calculate expected CCFOT, historical outbound data are utilized during 343 days of record. In addition to random variables, a performance measurement also needs to be defined. This measurement is used to select the qualified scenario within expected performance. Due to dispatch process strictly influences time efficiency, so that the expected lead time must be lower than the existing (< 703 min) and the expected CCFOT must be greater than or equal with 92% as KPI target. The possible scenarios are shown in Appendix 2.

From Appendix 2, each scenario has minimum and maximum estimated lead time and CCFOT. These minimum and maximum values are used as range to perform Monte Carlo simulation. Minimum lead time indicates the lowest lead time among those scenarios which lies on scenario 5 and it is used as lower level. Maximum lead time is the lead time that resulted from implementing each scenario of business solutions. The same goes with minimum and maximum CCFOT.
To begin running the simulation, each scenario is run 343 times. This is based on the number of days CCFOT recorded during 2011. This setting is also due to the need for data adjustment so that the effect of each business solution can be well-predicted to the expected lead time and CCFOT. The average lead time and CCFOT of each scenario that is run 343 times is used as expected value in simulation result so that a decision can be made regarding which scenario performs the best. The simulation result is shown in Appendix 3.

From Monte Carlo simulation result in Appendix 3, the expected lead time shows that all scenarios generate the expected lead time below the actual so that all scenarios are within desired performance measurement. The scenario with the lowest expected lead time is scenario 5. The simulation result of expected CCFOT shows that only scenario 1, 2, 3, 4, and 5 that achieve CCFOT requirement of equal or greater than 92%. Although expected lead time is important, the final decision is made based on higher expected CCFOT, because the CCFOT is a requirement that demanded by ULI as stated in contract. Based on this consideration, the final decision is made by choosing scenario 5 that performs best, which is by implementing all business solutions.

4. Conclusion and Implementation Plan

This research has been done to identify the causes of why LLI failed to achieve CCFOT target 92% and cases picking productivity target 200 cs/man hour in 2011 as well as what possible improvements need to be done to help management achieve the target.

To overcome the emerging root causes, several possible solutions are constructed by using future reality tree involve reengineering business process particularly in making new procedures which aimed to eliminate waste without hampered other processes. The possible solutions that have been constructed are just-in-time replenishment, replenishment cross-checking, ABC cycle counting, one-check loading strategy with punishment system, and re-confirmation process of truck availability. Business solutions are then run for Monte Carlo simulation with 15 possible scenario combinations. Lead time, total outbound during 2011, and CCFOT are utilized as inputs for this simulation. The simulation results showed that the combinations of all business solutions are predicted to give the lowest lead time 434 minutes compare to current 732 minutes and the highest CCFOT 94.9% compare to current 89.27%. This also agrees with cases picking productivity which predicted to increase to 400 cs/man hour compare to current 163 cs/man hour. It is calculated by considering the outbound traffic is 4400 cs/hour, 22 pickers/hour, and the cycle time is 0.5 hour on average. Pickers can now pick 4400/(22 x 0.5) which is 400 cs/man hour.

The timeline for implementation plan regarding those business solutions is shown in Figure 7.

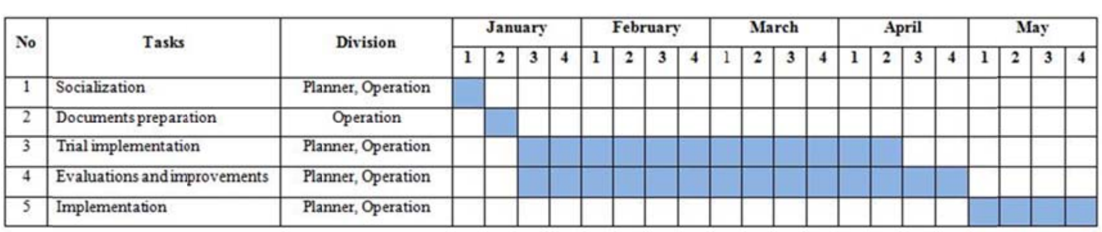

Figure 7. Timeline for Implementation Plan

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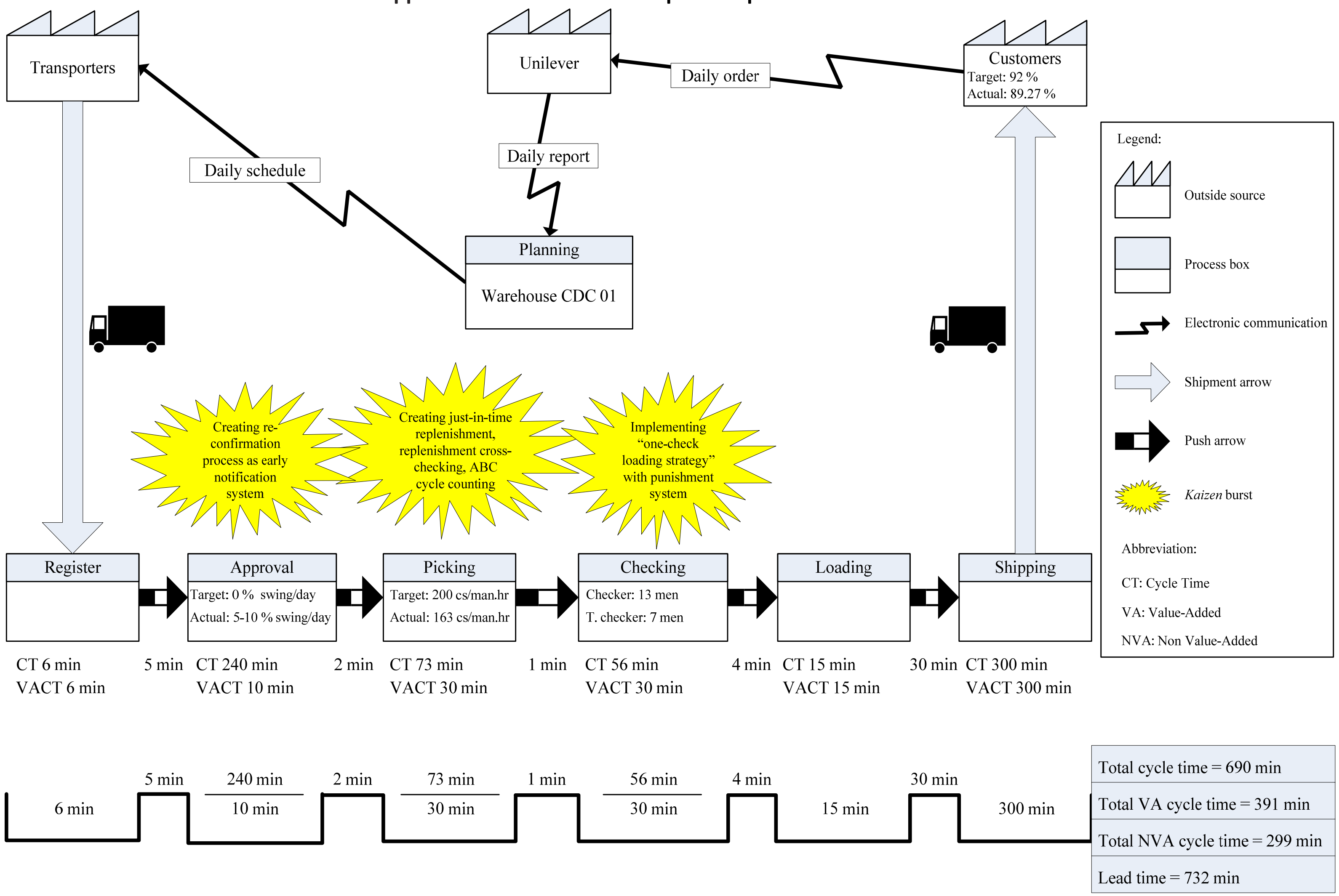
Appendix 1. Current State Map for Dispatch Business Process



Appendix 2 Scenario of Proposed Business Solution

Scenario	Just-in-time Replenishment	Replenishment Cross-checking	ABC Cycle Counting	One-check Loading	Re-confirmation Process	Estimated LT (min)		Estimated CCFOT	
						Min	Max	Min	Max
Existing	No	No	No	No	No	732	732	89.27%	89.27%
1	Yes	No	No	No	No	434	718	89.48%	97.85%
2	Yes	Yes	No	No	No	434	704	89.48%	98.28%
3	Yes	Yes	Yes	No	No	434	690	89.48%	99.36%
4	Yes	Yes	Yes	Yes	No	434	664	89.48%	99.79%
5	Yes	Yes	Yes	Yes	Yes	434	434	89.48%	100%
6	No	Yes	No	No	No	434	718	89.48%	89.70%
7	No	Yes	Yes	No	No	434	704	89.48%	90.77%
8	No	Yes	Yes	Yes	No	434	678	89.48%	91.20%
9	No	Yes	Yes	Yes	Yes	434	448	89.48%	91.42%
10	No	No	Yes	No	No	434	718	89.48%	90.34%
11	No	No	Yes	Yes	No	434	692	89.48%	90.77%
12	No	No	Yes	Yes	Yes	434	462	89.48%	90.99%
13	No	No	No	Yes	No	434	706	89.48%	89.70%
14	No	No	No	Yes	Yes	434	476	89.48%	89.91%
15	No	No	No	No	Yes	434	502	89.48%	89.48%

Appendix 3. Monte Carlo Simulation Result

Scenario	Just-in-time Replenishment	Replenishment Cross-checking	ABC Cycle Counting	One-check Loading	Re-confirmation Process	Expected LT (min)	Expected CCFOT
Existing	No	No	No	No	No	732 (Actual)	89.27% (Actual)
1	**Yes**	**No**	**No**	**No**	**No**	**566**	**93.61%**
2	**Yes**	**Yes**	**No**	**No**	**No**	**569**	**93.85%**
3	**Yes**	**Yes**	**Yes**	**No**	**No**	**562**	**94.33%**
4	**Yes**	**Yes**	**Yes**	**Yes**	**No**	**543**	**94.80%**
5	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**434**	**94.90%**
6	No	Yes	No	No	No	570	89.59%
7	No	Yes	Yes	No	No	574	90.10%
8	No	Yes	Yes	Yes	No	550	90.37%
9	No	Yes	Yes	Yes	Yes	441	90.49%
10	No	No	Yes	No	No	581	89.90%
11	No	No	Yes	Yes	No	569	90.09%
12	No	No	Yes	Yes	Yes	446	90.25%
13	No	No	No	Yes	No	567	89.59%
14	No	No	No	Yes	Yes	453	89.69%
15	No	No	No	No	Yes	467	89.48%